Task 9 Technical Memorandum
Technical Specifications of a Transit Center

Draft

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JACOBS Carter Burgess
Ordonez and Vogelsang, LLC Transportation Consulting
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Introduction

This technical memorandum presents site development specifications that could be used for potential transit stations along the I-70 corridor. The guidelines developed in Task 5 for routing and station locations provided the basis for the more specific technical specifications for transit center locations provided herein.

Background

The I-70 Coalition Land Use and Transit Study's County Working Groups have examined the role of future Advanced Guideway System (AGS) services along the I-70 corridor and discussed future connections between regional destinations and communities. The County Working Groups have identified Community Preferred Station locations (as described in Tech Memo 8), and examined the integration of those stations with local land use patterns and community characteristics. The Groups have discussed the functionality of stations including the anticipated need for passenger drop-off or kiss-n-ride facilities, bus bays for integration with local transit systems, and park-n-ride facilities.

Figure 1: Advanced Guideway System

The County Working Groups and the consultant team, however, cannot prescribe specific station types, sizes, or required levels of operation by location without projected ridership in the corridor and determination of AGS technology. The Rocky Mountain Rail Authority Study will be developing projected ridership and appropriate rail technologies after this study is complete. Without this information the County Working Groups and Technical Committee have discussed the general characteristics likely to be part of a primary or "Tier 1" station on the system. This memo is intended to supplement the County Working Groups' discussions of station location and function with more technical detail regarding sizing, operational requirements and amenities associated with Tier 1 stations. Typical platform, drop-off area, transit center and other station elements are described in detail for consideration in future planning efforts, and included in a typical footprint and a visual simulation of a Tier 1 station. Final details will likely vary by station due to site specific characteristics such as passenger types, boarding and alighting, community character, and adjacent land use. Secondary stations, Tier 2 or "milk-run" stations are assumed to be smaller in scale and require only elements of these larger facilities, as appropriate to each community and function.

1.0 The Function and Features of an Advanced Guideway System Transit Station, Tier 1 Concept

The station's primary function is to support rail or guideway operations and provide a platform for passenger access to the transit system. The transit station is the "front door" or entry point to the larger corridor of communities on the line. A station location should be designed to fit the context of the community, as well as the specific characteristics and land use needs of the site. The station should support not only the transit function but the image of the local community by acting as a public or civic space or as an anchor to an economically viable mix of land uses supportive of transit use. Planning for a station will bring together the technical facility requirements with the local needs for community integration.

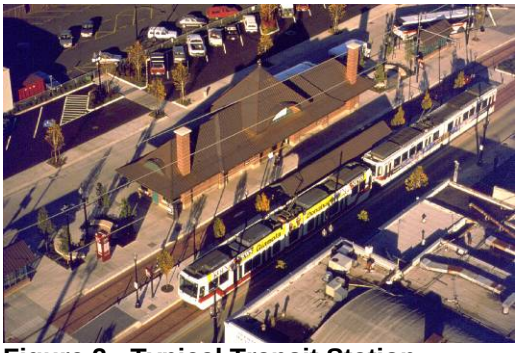

Figure 2: Typical Transit Station

For purposes of this study, the primary Community Preferred stations are termed "Tier 1" stations. These stations will eventually be designed and sized to serve the projected ridership, the community and regional operational functions, land use, and character/context of setting. The following elements are estimations of the requirements and sizing characteristics that could be associated with a Tier 1 station:

- Passenger Platform: Approximately 500 feet in length to accommodate a four car train.
- Passenger Drop-Off: Access lane or loop to accommodate up to 15 vehicles and provide pedestrian access to station platform.
- Transit Center: Transit drop-off/pick-up area with up to 8 bus bays located in close proximity to the station with pedestrian access to station platform. This facility could need to accommodate local transit connections, resort connections, and bus transfer operations.
- Park-n-Ride: Approximately 6-10 acres to support around four-storys of structured parking with 1500 parking spaces and vehicular access to the site. The required number of parking spaces and configuration of a multi-storied structure will depend on future ridership estimates, function and land availability of the specific station.
- Bike Parking: Lockers or racks to accommodate up to 30 bicycles.

The footprint of a Tier 1 station which includes the above components is illustrated in the following diagram set at Copper Mountain Ski Resort. This image is intended to provide basic sizing requirements of a Tier 1 facility and give communities a sense of the land requirements needed to accommodate this future operation. Specific site and structure requirements will need to be examined in future planning phases once more detailed ridership estimates are known.

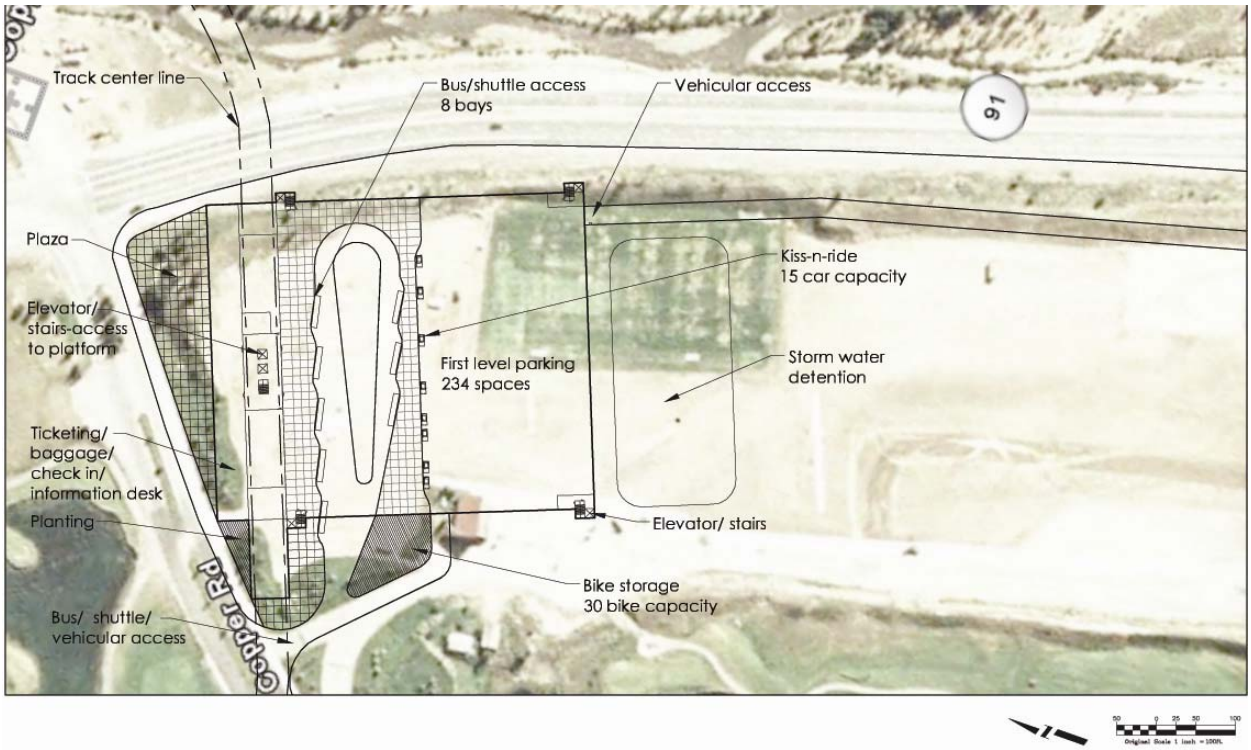

Figure 3: Plan View of the First Floor of a Tier 1 Station

The Tier 1 station's scale and massing is illustrated in the following visual simulation.

Figure 4: Visual Simulations Representing a Tier 1 Station

The basic elements or amenities typically associated with a Tier 1 station or a major corridor station include:

- Platform
- Bus interface
- Kiss and ride
- Parking
- Vehicular access
- Bike parking
- Baggage storage
- Ticketing
- Landscaping
- Stormwater detention
- Pedestrian/bicycle circulation

Figure 5: Station Platform

The exact combination of these elements will depend on the transit technology, layout of station and the particular needs of each station within its community. In designing a station layout there is a hierarchy for how these elements should be located in relation to access to the AGS vehicle. The first priority in the hierarchy is to provide convenient access to the pedestrian and bicyclist, the second priority is to accommodate access via other transit services or shuttles, and the final priority is to provide vehicular access to the site for passenger drop-off or park and ride facilities. Each element of a station has distinct characteristics associated with it. This section will provide details on the spatial requirements, safety considerations and varying options for each transit element. The unique characteristics of each element will form how each station will function and look.

1.1 Platform

A platform is a surface alongside rail tracks from which passengers board or alight from trains. A platform is a level hardscape surface that runs the complete length of the train boarding area. The platform should be located on a tangent track (straight track for at a minimum the distance of the platform and 100' on each side) with a longitudal slope not to exceed a 1% grade and a cross slope not to exceed 2%. To eliminate any conflicts between the AGS service and vehicular traffic, the platform should be constructed a minimum of 200 feet from roadway intersections. It is anticipated that an AGS operation will require platform lengths up to 500 feet.

Figure 6: Center loaded platform

Figure 7: Side loaded platform

There are three types of platforms. A platform can be a bay platform, a center loaded platform or a side loaded platform. A bay platform is where the tracks dead end, requiring a train to reverse in or out. A center loaded platform and a side loaded platform are both through-stations where the train pulls into the platform from one end and leaves by passing the other end. A center loaded platform is one platform located between two tracks serving both directions of train service. A side loaded platform consists of two platforms on the outside of the tracks. Each platform serves a single direction train.

The platform shall provide disabled passengers with a level boarding to the AGS vehicle, and be Americans with Disability Act (ADA) accessible. This can be accommodated by having a platform designed to be level with the AGS vehicle floor or providing a high or low block access on the platform to bring the disabled persons up to the vehicle floor level. The platform shall be designed so that "the horizontal gap between a car door at rest and the platform shall be no greater than 3 inches and the height of the car floor shall be within plus or minus 5/8 inch of the platform height under all normal passenger load conditions."[2] All platforms must have a visual and tactile warning system on the edge of the platform to keep passengers away from the tracks. This is done using a tactile warning strip consisting of 24-inch wide truncated domes that are a contrasting color to the adjacent ground plane and extend the length of the platform. The platforms should be slightly sloped upwards towards the platform edge to prevent wheeled objects such as strollers and wheelchairs from rolling into the path of the train.

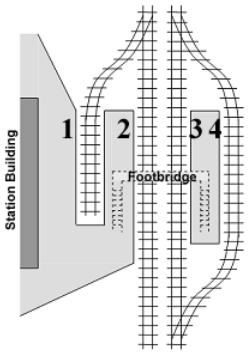

Figure 8: Platform Loading Types. *Platform 1 is a "bay" platform, while platforms 2, 3 and 4 are through platforms. Platforms 2 and 3 are side loaded platforms and 3 and 4 are center loaded platforms. 1*

When designing and sizing a platform it must be designed to meet the National Fire Protection Association (NFPA) 130 requirement. The NFPA 130 requirement sets design standards to ensure safe evacuation of the platform in case of a fire or emergency. This calculation takes into account the maximum number of passengers waiting on a platform and the crush load level of passengers on the vehicles at the platform and the frequency in train service. "NFPA 130 specifically states that passengers should be cleared from the platform in four minutes and at a point of safety in six minutes, unless tenability along the egress path can be established for a longer duration."[3]

Figure 9: 2'- wide Truncated Dome Warning Strip

[1] Wikepedia-[http://en.wikipedia.org/wiki/Railway_platform]
[2] Henry Perritt , Jr . *American with Disabilities Act, Forth Edition Volume 1*, Aspen Publishers, 673
[3] Robert C. Till, *Timed egress requirements for transit and passenger rail station evacuation as described in NFPA 130 ASHRAE Transactions, July, 2006l*

Platform Elements:

There are numerous elements that should be provided on the platform in order to create a convenient, pleasant environment for the transit patron. Elements that are typically found on a platform are:

- Overhead shelter (if located outside)
- Wind shelter (if located outside)
- Seating
- Trash receptacles
- Pedestrian lights
- Signage
- Message systems (variable message system and audio speakers)
- Emergency phone
- Security cameras
- Ticket vending machine and ticket validation (depending if a machine or attendant is used)


Overhead Shelter


Wind Shelter/Bench


Bench


Trash receptacle


Lights at a platform


Signage

Variable message system


Ticket vending machine

Figure 10: Platform Elements

When locating the elements on the platform a 6 foot clear zone must be maintained at all times. A platform must provide ease of pedestrian movement. The platform design should coordinate with the doors of the train so that boarding and alighting can occur smoothly even when long queuing lines are present.

To cross the tracks to access the platforms either a grade separated crossing or an at-grade crossing could be used. Both crossings would be required to be ADA accessible. Not knowing the technology that is being used on the I-70 corridor a safe assumption for a grade separated crossing would be to be 23'-6" from the top of guideway to the bottom of the bridge. This meets the standard requirements for freight rail design. Vertical access to the grade separated crossing could be provided with stairs, elevators and/or escalators. Two forms of access need to be provided in case of an emergency. This could consist of two vertical accesses or one vertical and one at-grade crossing. An at-grade crossing needs to take into account crossing safety considerations. Pedestrians need to have an awareness of approaching trains. This can be accommodated by signage or by limiting access across the tracks using fencing, z-crossings (typically mid-block crossing that cross the tracks at an angle in order to provide visual site line to trains, there is no gate so often flashing lights are used) or swing gates.

Figure 11: Swing Gate

Utilities will need to be provided on the platform. At a minimum, electricity, water and telecommunication lines would be required. Electricity is needed to operate the lights and message systems, water is required to wash the platform and potentially for emergency fire protection, and telecommunications lines are required to transmit video surveillance information, update message systems and carry transmissions from the emergency phone.

It is anticipated that in addition to passenger service, the I-70 Corridor AGS will carry light freight to and from the mountain corridor communities. Not knowing what kind of freight service will be provided or if the AGS would utilize existing tracks, information is being provided for a conservative design for light freight rail compatibility requirements. Stations may not need to meet them if the AGS does not provide freight access at this location.

Often time freight cars are required to carry oversized objects requiring the freight car to be larger than the typical car. If high level platforms are used, two options are available. The platform can be set back several inches outside of the dynamic envelope, and ADA access can be provided by a bridge plate (ramp) between the passenger car and the platform. Regular passengers would simply step across the slightly wider gap. Otherwise, special track work will be required (typically gauntlet or bypass tracks) to allow freight trains to travel further away from the platform.

If low level platforms and ADA blocks are used, the ADA blocks will have to be set back in a manner similar to high level platforms. Many systems today use a bridge plate for ADA access with ADA blocks, so the operational impacts are a part of normal service. The low-level

platform will also be required to meet both freight and passenger rail clearances. These clearances are very similar in the area between the top of rail and the typical 6" to 9" height of low-level platforms.

The platform needs to be sized to allow for loading and unloading of freight. The platform needs to extend the length of the entire passenger and freight train and provide a large enough space on the platform for equipment to maneuver to load and unload freight and to transport the freight to truck service. Trucks need to be provided a space adjacent to the platform in order to pull in and load and unload the freight.

1.2 Bus Interface

There are numerous bus systems serving the local communities along the I-70 corridor. In the future, local transit services will likely expand to carry a greater number of passengers between the mainline station and local destinations. The following transit agencies operate in the I-70 corridor and will be critical to future connectivity within corridor communities:

- Regional Transportation District (RTD)
- Summit Stage
- Eagle County ECO Transit
- Roaring Fork Transit Agency (RFTA)
- Resort and community shuttle services

Figure 12: Transit Center

The local transit systems have numerous types and sizes of buses in service. They have regional buses, bus rapid transit (BRT), local buses and shuttle service. In order to accommodate the variety of needs for the different bus types and sizes, facilities will need to be designed to serve a 60 foot long and 10'-6" wide vehicle with a 16'-6" vertical clearance. Access roads servicing the bus system should be designed using a minimum of a 32 foot inside radius for bus turning movements. In addition to the integration with local bus systems, the AGS service will need to interface with shuttles, van pools and taxis. Local bus service and shuttles will be a significant component in connecting the AGS system to the destinations and the local community.

Figure 13: Shuttle Service

In laying out the transit station, buses should have a high priority and be given easy access to the station. The number of buses to be accommodated at each transit station would be determined by the local transit operator, the local municipality and the resorts. The number of bus bays should be based on the maximum number of

transit vehicles that would serve the station at one time. The local transit agency and municipality will need to work together to determine if an on-street facility or off street facility best serves the station.
An on-street facility is efficient in utilizing minimum space and reducing travel times for through passengers. An off street facility serves larger volumes of passengers, provides easier transfers, allows for bus layovers and allows a space for passengers to load and unload baggage. To maintain travel time and pedestrian safety an off street facility should separate bus circulation from vehicular traffic. When designing an off street facility, planners typically account for 4,250 square feet for each bus. This takes into account an access lane, landscaping and a detention pond. Depending on site configuration access lanes could require additional space.

Figure 14: Bus Bays

Figure 15: Bus Plaza

The bus service at a transit facility could be constructed in the following configurations;

- Linear bus bays
- Sawtooth bus bays
- Angled bus bays (requiring the bus to back out)
- On-street bus stops

The bus facility should accommodate seating, trash receptacles, newspaper dispensers and a shelter to serve the waiting bus patrons. The bus facility should accommodate layover space and amenities (toilet and sink) for drivers.

1.3 Passenger Drop-off

The passenger drop-off area is a place where automobiles are permitted to stop and park temporarily to drop off or pick up transit patrons. The vehicle lane should be located in close proximity to the transit station with convenient pedestrian access to the platform. A passenger drop-off should be sized to serve approximately 2-5% of the estimated parking demand for the facility. Assume 325 square feet per car to account for an access lane, space to stop, sidewalk and landscaping. The passenger drop-off could be configured as a separate access loop, on-street drop off with signed designation or incorporated in the park and ride structure. Vehicular access

Figure 17: Kiss and Ride Loop

Figure 16: On-Street Kiss and Ride

to the passenger drop-off should be from an arterial or secondary road and needs to be easy and convenient.

1.4 Parking

The number of parking spaces at each transit station is determined through a combination of a ridership forecast and community planning. The ridership forecast takes into account the number of projected riders, the capture area, the proximity to other stations, the presence of a feeder bus system and whether it is an end of the line station. Community planning factors in plans for transit oriented development (TOD), walkability of the location, land availability, traffic impacts, traffic capacity, potential for shared parking, and community vision. By combining the ridership forecast with the community planning factors the number of parking spaces at the park and ride is determined.

Figure 18: Park and Ride

When designing a park and ride, there is not a typical prototype that can be applied everywhere. Each park and ride needs to respond to its land configuration, topography, local municipal requirements, vehicular access and pedestrian access. A park and ride is configured as either a surface parking lot or structured parking. A surface parking lot parks all of the cars at-grade, while a structured parking lot parks cars vertically. Whether a park and ride is going to be a surface parking lot or a structured parking lot is determined by land availability, location, community desire, budget and the number of parking spaces required. A structured park and ride is more expensive per car but frees up valuable land for other land uses. A surface parking lot is less expensive to construct but requires more land.

Figure 19: Structured Parking

When designing a surface park and ride account for 500 square feet for each car. This equates to roughly 85 cars per acre. The 500 sf takes into account the space required for a 9’ wide x 19’ long parking space, access drives, a 24’ wide travel aisle, pedestrian access, landscaping, and detention ponds. Landscaping requirements are determined by each municipality in their zoning code. In order to maximize the space, parking is recommended to be right angle parking. When designing a structured park and ride account for 285 square feet for each car. The 285 sf takes into account the space required for a 8’-6” wide x 17’-8” long parking space, the structure, two elevator cores and two sets of stairs. A percentage of parking needs to be provided for the

disabled. The amount of disabled spaces shall follow local code requirements; typically this is about 4 spaces per 100 parking spaces. Disabled parking spaces need to be clearly marked and are typically wider than the typical parking space to accommodate a loading area. The disabled parking space should be located in close proximity to the transit center with safe accessible access to the station.

The location of the park and ride and its access points should be designed to provide safe convenient access while minimizing disturbance to local traffic. Park and ride access should occur on arterials where feasible. Direct park and ride access to I-70 is generally precluded by Federal Interstate standards. Arterials that access I-70 at interchanges could provide access to park and ride facilities with I-70 connectivity. The details of traffic signalization, number of access points, and other traffic flow elements depend on the station site and local development requirements.

Local zoning code will state design requirements for parking lots. At a minimum the park and ride should be configured and designed to reduce the overall mass and visual dominance of paved areas. To accomplish this, the following basic guidelines should be incorporated. The parking aisles should not exceed 20 contiguous parking spaces in length. To help break up the visual impact of the pavement and improve the aesthetic environment a landscaped island should be provided between approximately every 20 parking bays. This landscaped island should be sized appropriately to accommodate a tree and low level vegetation. In cases where land is at a premium, the islands could also be used as water quality facilities to minimize the impact of a large detention pond. Landscaping would require a maintenance program. When laying out the park and ride, walking distance should be kept in mind. According to the Washington Metro Area Transit Authority the maximum walking distance that a transit patron would be willing to walk from a parked car to the bus loading area is 1500 feet.[4]

The park and ride must incorporate walkways as an integral design component to safely move pedestrians in this auto dominated environment. To promote a safe pedestrian environment, parking should be perpendicular to the station access. This provides a clear, visible zone for pedestrians to walk. Pedestrian walkways should be clearly marked. When possible, pedestrian sidewalks should be separated from vehicular traffic with a curb and a landscape buffer. Walkways should be a minimum of 5 feet wide.

Figure 20: Pedestrian Connection Through Park and Ride

Park and rides should be equipped with directional signage, site lighting and trees. Appropriate lighting levels with consistent coverage should be provided in parking areas to provide a safe environment. The height and intensity of light standards should be sensitive to adjacent land uses.

[4][http://www.wmata.com/metrorail/bike_workshop/Safety_and_Access.pdf]

The park and rides are expected to have utilization restrictions associated with them. Some restrictions to consider would be:

- Would parking be free or is there a cost associated with parking?
- Would there be time limits or restrictions?
- Would passengers be allowed to park overnight?
- Would there be any assigned parking spaces?
- Would there be a vehicle size restriction (campers, RV's)?

Restrictions to be applied would be determined by the operating transit agency and the local municipality. Restrictions at a park and ride would require personnel to enforce the restrictions. If there is a fee for parking either a parking attendant or a ticket machine would be required. Enforcement at the park and ride is also necessary to create a safe environment for patrons. If the park and ride is located in close proximity to residential housing, a permit parking program should be considered for the surrounding neighborhoods. This would discourage patrons from parking on local streets instead of the park and ride.

1.5 Bicycle Parking

In order to promote a multi-modal transit facility, convenient and secure bicycle parking needs to be provided. The parking for bicycles should be sized to serve approximately 2% of the parking. If there is no parking, enough parking spaces should be provided to meet the municipal standards. Approximately 18 square feet for each bicycle storage unit should be assumed. This takes into account the average space requirement for a rack and a locker. Bicycle parking could come in a variety of forms. Bicycle parking could be open air bike racks, enclosed lockers, a secured covered storage system, or a bike station. A bike station consists of bicycle parking, bicycle rentals, transit and route information, changing rooms, and a bicycle repair shop. Each community needs to evaluate their storage needs to determine which storage element or combination of elements should be used. Bicycle parking should be located in close proximity to the platform and clearly visible from the approach. It should be visible, accessible, easy to use, convenient, and plentiful. It should be well lit, and in plain view without being in the way of pedestrians or motor vehicles. In addition, AGS vehicles, local buses, and shuttles should accommodate bicycle storage.

Figure 21: Bikes Leaving a Train

Open air bike rack

Enclosed bike locker

Bike station

Figure 22: Bicycle Parking Facilities

1.6 Ticketing

There are two options for ticketing. One is to have a ticket vending machine where patrons purchase a ticket and then enter the train. Once on the train a security guard randomly checks for tickets. The other option is to pay a ticket attendant and then submit your ticket for access through a turnstile. Ticketing should be centrally located in a convenient place that serves the pedestrian, bicyclist, transit commuter, park and ride patron, and kiss and ride patron. The location should make it as easy as possible for an AGS patron to purchase a ticket and access the AGS vehicle. When using a ticket vending machine, multiple options should be evaluated. A ticket vending machine could be provided at the park and ride and the platform. Both ticketing options have space requirements that will need to be taken into consideration when designing the platform and station. The need for security check of passengers should be evaluated. If a security check is recommended than the ticketing turnstile entrance might be an ideal location for this to occur.

Ticket vending machine


Ticket attendant

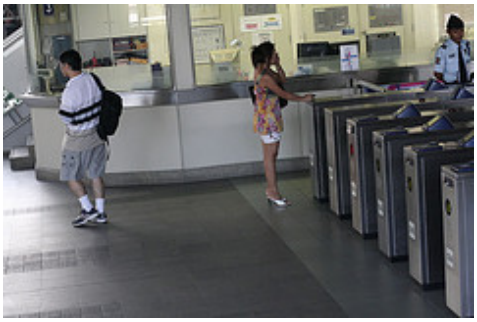
Ticket turnstile entrance

Figure 23: Ticketing Facilities

1.7 Baggage

The AGS stations on the I-70 corridor need to have a system in place to handle baggage. The baggage system needs to handle the variety of needs of the different travelers. There are day trippers transporting recreational equipment and/or minimal luggage and the longer-term travelers that have recreational equipment and/or baggage. Understanding this recreational equipment could be anything from skis, bicycles, golf clubs or kayaks; the space set aside for baggage needs to be large enough to accommodate these large bulky items.

The baggage system could be handled in a number of different ways. Transit patrons could be responsible for their own luggage, taking their luggage on and off the AGS vehicle. The luggage could either be loaded into their compartment or it could be loaded on to a separate compartment of the train designated for bags. Another option would be to have a baggage check system where you would check in your bags and then a baggage handler would load and unload your baggage on the AGS vehicle. At the end of the trip, the luggage could be delivered to a specific location on the platform, inside the train station or to a carousel system. There could also be a baggage

check system, where the baggage is checked in and then delivered directly to your destination. The needs for a security check of baggage should be evaluated.

Patrons responsible for their own baggage

Baggage unloaded from transit vehicle and stored at one spot

Baggage check-in

Patrons self loading a baggage compartment

Carts for patrons to move baggage

Baggage carousel

Figure 24: Baggage Handling Facilities

1.8 Train Depot

The amenities at each station can vary greatly depending on the individual needs of each station. A train depot could enhance a station and provide convenient amenities to the AGS patrons. A train depot offers an indoor atmosphere protected from the outdoor elements to wait for the AGS, local bus or shuttle, purchase tickets and obtain information. In addition a train depot could offer luxuries such as retail shopping and restaurants. The following services could be provided at a train depot:

- Ticketing for AGS service
- Ticketing for ski resorts and other local activities
- Information (hotel, ski resorts, activities)
- Shuttle Information
- Bus Information
- Restrooms/ Showers/Baby Changing Area

Figure 25: Bern Train Station, Switzerland (acts as an activity center)

- Lockers (As stated in the baggage section, the AGS patrons are going to be traveling for a variety of reasons. It would be beneficial to have plenty of lockers for day and overnight use)
- Restaurants
- Retail
- Currency exchange
- Post office
- Internet access

1.9 Stormwater

New hardscape surface would be added to the land as a result of building a new station. With this additional hardscape surface comes a need to accommodate additional stormwater detention. Stormwater detention could be handled with detention ponds or tied into an existing municipal drainage system if the system has enough capacity to accommodate the additional flows. If stormwater detention is to be handled with a detention pond than assume a space requirement for the detention pond of approximately 10% of all new hardscape surface.

1.10 Utilities

Numerous utilities would be needed to service a transit station. Water, electricity, telecommunication lines and sanitary sewer are required to service the different elements that comprise a station. Water is required for fire protection services, cleaning, restrooms and irrigation. Electricity is required to power lights, potential baggage services, potential ticket vending machines, elevators or escalators and variable message system. Telecommunication lines are necessary for elements like emergency phones, security cameras and variable message signs. Sanitary sewer service is required to service the restrooms.

2.0 Next Steps

The station information provided in this technical memorandum is based on input from the County Working Groups supplemented with consultant team recommendations of typical elements and amenities. The Tier 1 station concept, as presented, should be coordinated with the results of the RMRA study and the I-70 Programmatic EIS, as appropriate. Layout details, access concepts, parking demands, and other amenities will likely vary by station, pending input from these studies and other future transit planning and engineering along the I-70 corridor.

3. 0 References

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